REMARKS/ARGUMENTS

Applicant responds herein to the Office Action dated July 17, 2007. A Petition for Extension of Time (one month) and the fee therefor are submitted herewith.

Claims 1-6, 8, 9, 11-21 and 23-30 are canceled without prejudice or disclaimer. Therefore, claims 7, 10 and 22 are the claims currently pending.

Claims 7, 10 and 22 are amended to clarify features recited thereby.

Objection to Claims 21 and 23

Claims 21 and 23 are objected to under 37 C.F.R. § 1.75 as being a substantial duplicate of claims 7 and 11.

Claims 21 and 23 are canceled without prejudice or disclaimer, and accordingly this objection is moot.

Rejection of Claims 7, 8, 10, 21, 22, 27 and 29 under 35 U.S.C. § 103

Claims 7, 8, 10, 21, 22, 27 and 29 are rejected under 35 U.S.C. § 103 as being obvious from Aoki (5,635,053), in view of Okuda (2002/0035762), as evidenced by Verhaverbeke (5,972,123), Tomita (6,431,185), and Skee (6,465,403). Reconsideration of this rejection is respectfully requested.

Claim 7 requires a first step of supplying an alkaline solution to a surface of a substrate, a second step of supplying an acid solution to the surface of the substrate after the first step, and a third step of supplying the alkaline solution to the surface of the substrate after the second step.

According to an aspect of applicant's invention a substrate processing method comprising three major operations is provided. The processing method includes a first step of supplying an alkaline solution to a surface of a substrate, a second step of supplying an acid solution to the surface of the substrate, and a third step of supplying an alkaline solution to the surface of the substrate after the second step. According to an aspect of the present invention, the alkaline solution in the first step and the third step is supplied by injecting droplets that are formed by mixing the alkaline solution with gas. Accordingly, the process according to the present invention achieves an efficient removal of particle and metal contaminants from the surface.

By way of illustration, in the first step, as droplets of the alkaline solution are injected to the surface of the substrate, particles are removed from the surface as a result of the physical impact of the droplets. In the second step, since an acid solution is supplied to the surface of the substrate, metal contaminants adhering to the surface of the substrate dissolve and thus may be removed. Also, since the surface of the substrate may be slightly etched as a result of the second step, particles may come up to the surface of the substrate as a result of the etching, which can be removed in the third step in an efficient manner. According to an aspect of the invention, in the third step, as droplets of the alkaline solution are injected to the surface of the substrate, particle and metal contaminants that have come up to the surface are removed by the physical impact of the droplets. Thus, a novel method is provided according to an aspect of the invention by the three steps above-described. Therefore, according to an aspect of the present invention, the amount or degree of etching of the surface may be reduced or minimized.

The Office Action acknowledges the cited art is silent about the etching effect that may take place when supplying the acid solution in the second step (Office Action, page 4). However, the Office Action alleges that when the same acid solution is supplied on the same surface of the substrate, it would be expected that the method of the combined pieces of prior art would contain the same properties and functions as claimed. Applicant respectfully disagrees with this assertion for the following reasons.

Many methods have been developed in recent years in the field of substrate manufacturing for the removal of foreign materials, including foreign materials or other contaminants buried in the surface of the substrate adhering solidly to the surface of a substrate. In the conventional methods, including in the methods disclosed in the cited art, during the removal of such foreign contaminants, surface of a substrate is etched by supplying an acid solution to the surface of the substrate and thus foreign materials are lifted off by lowering or etching the surface level of the substrate. Accordingly, in these conventional methods, the surface of the substrate must be etched quite deeply as shown in Reference Drawing I presented in the Appendix of the Amendment filed on April 6, 2007.

As explained in the foregoing discussion with respect to lack of anticipation, after supplying an acid solution having an etching effect to the surface, droplets of an alkaline solution

are supplied to the surface. Thus, foreign materials can be removed even without further etching until the foreign materials adhere solidly to a surface of a substrate are completely lifted off. In particular, the Examiner's attention is drawn to Reference Drawing II presented in the Appendix of Amendment filed April 6, 2007. As illustrated, if the surface is etched only to some extent, foreign materials can still be removed due to the physical effect of the injection of droplets.

Thus, alkaline droplets of a particular type, as discussed, alkaline droplets mixed in an external-mix bi-fluid nozzle are injected to the surface at this point in the processing. Accordingly, the degree to which the surface is etched is suppressed but the foreign contaminants are still effectively removed.

The cited references, even taken together in combination, do not disclose or suggest "after supplying an acid solution having an etching effect to a surface substrate supplying droplets of an alkaline solution to the surface." Okuda discloses a substrate processing apparatus that generates a process liquid mist mixing liquid and pressurized gas which removes products from a substrate (Okuda, Abstract).

Okuda does not disclose or suggest supplying an alkaline solution, an acid solution, and then an alkaline solution, in that order, to the surface of a substrate. The Examiner has acknowledged that Okuda does not disclose two or three of these steps (Office Action mailed August 16, 2006, page 3). Therefore, Okuda does not disclose or suggest the substrate processing method claimed in claim 7.

Okuda and the other references, even taken together in combination, do not disclose or suggest the combination of operations claimed in claim 7. The combination of operations in the order described has a synergistic effect and provides the above-discussed effect or advantage not provided by any of the operations performed alone or performed out-of order. Therefore, it is respectfully submitted that the recitations of claim 7 are not disclosed by and would not have been obvious based on Aoki, Okuda, Verhaverbeke, Tomita and Skee, even taken together in combination. Further, the cited references do not disclose or suggest the above-discussed effects or advantages.

Applicant notes that the present invention is not simply a repeated supply of alkaline solution and a supply of an acid solution, but should be thought of as a distinct combination of

steps that is effective to remove contaminant effectively from a substrate surface. As discussed, compared with conventional lift off and removal of extraneous particles from the substrate surface using only etching, the present invention removes extraneous particles from the surface while suppressing the amount of etching of the surface. The experiment result illustrated in Fig. 29 of the present application shows that the present invention achieves a high particle removal rate using the above-described three steps.

In addition, claim 1 recites that in the first step and in the third step of the present invention, droplets of the alkaline solution are generated using an external-mix bi-fluid nozzle. Using the external-mix bi-fluid nozzle, extremely small and uniform droplets of the alkaline solution can be generated, and thus the physical impact of the droplets at the surface of the substrate can be made more uniform.

In particular, employing the internal-mix bi-fluid causes the problem of droplets with non-uniform diameters, and thus excessive physical impact to the partial surface of a substrate. Accordingly, by employing the external-mix bi-fluid nozzle, this problem is mitigated. Thus, in the first step and in the third step of the present application, the etching amount of the surface and the damage to the surface of the substrate are suppressed further by employing the external-mix bi-fluid nozzle. By way of contrast, the substrate processing method of the present invention does not use the external-mix bi-fluid nozzle in the second step in which the acid solution is supplied. Thus, etching of the surface of the substrate can be suppressed even further. This is recited clearly in claim 7, which states that only in the supplying of the alkaline solution in the first step and in the third step are droplets or solutions applied to the surface by injection from the bi-fluid nozzle.

Further, the substrate cleaning method of the invention does not simply repeat the supply of an alkaline solution and the supply of an acid solution, but also performs rinsing with the ionized water after processing using the above-described three steps. In particular, sufficient removal of particles and metal contaminants is achieved by the present invention by processing using the above-described three steps. Therefore, there is no need to repeat the process of supplying an alkaline and acid many times which would exacerbate the problem of etching of the surface. Moreover, by performing the rinsing using the ionized water after the supplying of the alkaline

solution, the rinsing can be stopped in a shorter time compared with a case of performing rinsing after supplying of the acid solution. Accordingly, the cited references do not disclose or suggest recitations of claim 7.

Further, none of the cited references disclose employing an external-mix bi-fluid nozzle only for the supplying of the alkaline solution during the above-discussed steps. Accordingly, the cited art does not disclose or suggest the effect or advantage of suppressing the etching amount and damage to a surface by employing external-mix bi-fluid nozzle. Accordingly, claim 7 would not have been obvious based on the cited references even taken together in combination.

Claims 10 and 22 dependent from claim 7 and are therefore patentably distinguishable for at least the same reasons.

Rejection of claims 11, 12 , 14, 23, 24, 28 and 30 under 35 U.S.C. § 103

Claims 11, 12 , 14, 23, 24, 28 and 30 are rejected under 35 U.S.C. § 103 as being obvious from Aoki, Hall (4,326,553), or Bran (6,039,059), as evidenced by Okuda, Verhaverbeke, Tomita and Skee. Claims 11, 12 , 14, 23, 24, 28 and 30 are canceled without prejudice or disclaimer and therefore this rejection is moot.

In view of the foregoing discussion, reconsideration of the rejections is respectfully requested and allowance of the claims of the application is believed to be warranted.

Accordingly, the Examiner is respectfully requested to reconsider the application, allow the claims as amended and pass this case to issue.

Respectfully submitted,

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MAX MOSKOWITZ
Registration No.: 30,576
OSTROLENK, FABER, GERB & SOFFEN, LLP
1180 Avenue of the Americas
New York, New York 10036-8403
Telephone: (212) 382-0700